APPENDIX I

GLOSSARY

(**NOTE:** Refer to page AI-4 for a glossary of chemicals used in water treatment.)

ABFC—Advanced Base Functional Components.

AERATOR—Device for removing certain dissolved gases during water treatment.

AEROBIC DECOMPOSITION—Bacterial decomposition that occurs in the presence of oxygen.

AFTERCOOLER—A device which cools the final discharge from a compressor.

ANAEROBIC DECOMPOSITION—Bacterial decomposition occurring in the absence of free oxygen.

ANGLE—A figure formed by two lines or planes extending from, or diverging at, the same point.

ANGLE VALVE—A stop valve that is actually a combination valve and elbow since its outlet branch is at right angles to its inlet branch.

AQUIFER—A geological water-bearing formation that can provide water for wells.

ARCHITECTURAL PLAN—Show design and composition of a structure, including floor plans, building sections, and elevations.

BACK-PRESSURE VALVE—A valve similar in design to a low-pressure valve that is capable of opening independently of the pressure, thereby giving free exhaust.

BACTERIA—Living organisms, microscopic in size, which consist of a single cell. Most bacteria use organic matter for their food and produce waste products as a result of their life processes.

BILL OF MATERIAL—A list of all materials required to complete an installation based on takeoffs and estimates.

BLUEPRINT—A photographic print consisting of white lines on a blue background. It is used for copying architect's plans, drawings, and so forth.

BUSHING—A plumbing fitting used to reduce from one size of pipe to another size of pipe.

BUTTERFLY VALVE—A two-position valve with a vertical or horizontal disk.

BTU—British thermal unit, a measurement of heat.

CALCIUM HYPOCHLORITE—$CaC1_2O_2$, a granular white powder used to disinfect water.

CAP—A plumbing fitting used to close off a length of pipe.

CAULKING IRON—A plumbing tool used to compact or caulk lead wool or poured lead into a cast-iron pipe joint.

CBMU—Construction Battalion Maintenance Unit.

CBR—Chemical, Biological, and Radiological.

CBU—Construction Battalion Unit.

CEC—Civil Engineer Corps.

CENTIGRADE—A thermometric scale in which 0 degrees represents the freezing point and 100 degrees represents the boiling point of water at a pressure of 1 atmosphere. Is used with metric units of measure. Equal to the international thermometric scale of Celsius.

CHECK VALVE—An automatic nonreturn valve or a valve which permits a fluid to pass in one direction but automatically closes if the fluid begins to pass in the opposite direction.

CHLORINATION—The disinfection of a substance or container by a chlorine chemical or gas.

CHLORINE—A natural chemical element (Cl). A powerful disinfectant, used extensively in water treatment. As a gas, its color is greenish yellow, and it is 2 1/2 times heavier than air. As a liquid, its color is amber, and it is about 1 1/2 times heavier than water. It is an oxidizer and is toxic to all organisms and corrosive (in the presence of water) to most metals.

CIVIL PLANS—The essential data for layout, location, and site for a construction project, including boundaries, elevations, roads, utilities, structures, and references of both existing and finished construction.

CLARIFICATION OF WATER—The removal of suspended materials to produce a clear, clean liquid.

CLEANOUT—A fitting installed in waste lines to permit removal of stoppages and cleaning lines.

COAGULANTS—The chemicals added to destabilize, to aggregate, and to bind together colloids and emulsions to improve settleability, filterability, or drainability.

COLIFORM—The coliform groups of organisms are a bacterial indicator of contamination. This group has as one of its primary habitats, the intestinal tract of human beings. Coliforms also may be found in the intestinal tract of warm—blooded animals and in plants, soil, air, and the aquatic environment.

COMSECONDNCB—Commander, Second Naval Construction Brigade.

COMTHIRDNCB—Commander, Third Naval Construction Brigade.

COPPER SULFATE—(Blue Vitriol) Chemical used to remove tree roots from sewer lines.

COUPLING—A plumbing fitting used to join two lengths of pipe in a straight run.

CROSS-CONNECTION—In plumbing, a physical connection through which a supply of potable water could be contaminated, polluted, or infected. A physical connection between a potable water supply and one of questionable origin.

DEGREE OF TEMPERATURE—Measurement of heat intensity.

DIATOMACEOUS EARTH—A porous mineral powder, used as a filtering medium for the removal of suspended materials.

DIRECT LABOR—All labor that contributes directly to construction tasks.

DISINFECTION—The chemical destruction of bacteria.

EFFLUENT—Discharge water from a sewage or water treatment plant or equipment.

ELECTRICAL PLANS—All electrical interior and exterior wiring, electrical systems and equipment, including receptacles and light circuits, and power supplies to building and electrical appliances.

ELBOW—A plumbing fitting used to change the direction of a length of pipe at 90° and 45° angles.

EVAPORATION—A process of converting a liquid, by heat, into a vapor or gas.

FERRIC CHLORIDE—$FeCl_3$, a dark salt that hydrates to a yellow-orange form. Used in sewage treatment as an astringent.

FILTRATION—The process of removing organisms, minerals, turbidity, color, taste, and odor in water during the water treatment process.

FITTINGS—Devices which when placed in a pipe system make branch connections or changes in a direction of a line.

FORMULA CHART—Chart used to control the wash cycle of the skid-mounted laundry unit.

GATE VALVE—A sluice with two inclined seats between which the valve wedges down in closing. The passage through the valve is in an uninterrupted line, and when the valve is opened, the sluice is drawn up into a dome or recess, leaving an unobstructed passage to the full diameter of the pipe.

GENERAL REQUIREMENTS—First division of a set of specifications that describe general materials, characteristics, and methods for a project.

GLOBE VALVE—A valve with a round, ball-like shell, that is used for regulating or controlling the flow of gases or steam.

GPD—Gallons per day.

GPH—Gallons per hour.

GPM—Gallons per minute.

GROUNDWATER—Water absorbed by the earth's surface and collected below the waterline.

HEAD—The increase of pressure resulting from the addition of energy to a liquid by a pump.

HEAT—The energy that is measured in British thermal units.

HTH—High-Test Calcium Hypochlorite.

HYDRATED LIME—(Caustic Lime) A dry white powder, a strong base (alkaline), consists of calcium hydroxide made by treating caustic lime with water. Used to balance water pH and absorb chlorine.

HYDROLOGIC CYCLE—Process by which water is circulated from ocean to atmosphere to earth's surface.

ID—Inside diameter.

INCUBATION PERIOD—The period between the infection of an individual by a pathogen (bacteria) and the manifestation of the waterborne disease.

INFLUENT—Water flow into a sewage or water treatment plant or equipment.

INTERCOOLER—Device that cools compressed gases between stages in a compressor.

ISOMETRIC DRAWING—A drawing that visualizes a three-dimensional picture in one drawing.

JOINING—All the procedures used to connect pipes together.

MAIN SOIL AND WASTE VENT—The portion of the waste stack that extends above the highest fixture branch.

MAN-HOUR—A unit of measure used in estimating project labor hours. One man-hour is equal to one man doing 8 hours of work in 1 day.

MAPP—An all-purpose industrial fuel used with gas-welding equipment—methyl-acetylene propadiene.

MATERIAL TAKEOFF—The estimate of materials required for a job based on plans and specifications.

MECHANICAL PLANS—-All layouts and details for systems of plumbing, heating, ventilating, air conditioning, and refrigeration.

METHANE—An organic gas, produced in a sewage system by the decomposition of organic materials.

MULTISTAGE PUMP—A pump having two or more devices for imparting a moving force upon a liquid.

NAVFAC—Naval Facilities Engineering Command.

NET POSITIVE SUCTION HEAD—Pump suction pressure minus vapor pressure expressed in feet of liquid at the pump suction.

NCR—Naval Construction Regiment.

NCTC—Naval Construction Training Center.

NMCB—Naval Mobile Construction Battalion.

OD—Outside diameter.

ORANGEBURG ALKACID—Bituminous fiber drainage pipe designed with an alkaline base.

ORTHOGRAPHIC DRAWING—A drawing that visualizes a two-dimensional picture in one drawing.

PACKING—Materials used to seal moving machinery joints against leakage.

PERMEABILITY—The capacity of stratum material to transmit water under pressure.

pH—A value used to measure the acidity or alkalinity (basic) of a substance. A pH scale is from 0 to 14, with 7.0 as neutral. Below 7.0 on the scale is acid, and above 7.0 on the scale is alkaline or basic. Used in water treatment and purification.

PLUG—A plumbing fitting used to close off a fitting or a length of pipe by screwing into the fitting or pipe.

POROSITY—The property of stratum material that contains openings through which water may flow.

POSTCHLORINATION—Disinfection after filtration during the water treatment process.

POTABLE WATER—Water suitable for drinking, cooking, and personal use.

POTASSIUM HYDROXIDE—(Caustic Potash) KOH, a white powder, strongly basic (alkaline), when dissolved in water produces heat. Used to balance water pH and absorb chlorine. Also used as a reagent.

PPM—Parts per million.

PRECHLORINATION—Disinfection before filtration during the water treatment process.

PRESSURE-RELIEF VALVE—A spring-loaded valve that opens when pressure is applied to the spring and relieves the pressure in a pressure vessel when the pressure of the vessel is beyond its safe working pressure.

P-TRAP—A type of fixture trap, used to seal sewer gases in the sewer piping.

PSI—Pounds per square inch.

PUMP—A mechanical device which applies a force to move any substance that flows or can be made to flow.

REDUCING VALVE—A spring-loaded or lever-loaded valve similar to a safety valve, designed to maintain a lower-end constant pressure beyond the valve.

REVERSE OSMOSIS—A process whereby a solution flows through a semipermeable membrane into an area of lower solute concentration.

ROUGHING IN—The installation of all parts of a plumbing system; completed before installation of fixtures.

ROWPU—Reverse Osmosis Water Purification Unit. A mobile, lightweight unit capable of being air lifted to a deployment site.

SINGLE-STAGE PUMP—A pump having one device for imparting moving force upon a liquid.

SODIUM CARBONATE—Na_2CO_3, salt of carbonic acid, strongly basic (alkaline). Used in water softening and balancing water pH.

SODIUM HYDROXIDE—(Caustic Soda) NaOH, a strong base (alkaline), white powder used to balance pH in water and absorb chlorine.

SODIUM HYPOCHLORITE—NaOCl, a salt usually furnished in solution, used for disinfection of water.

SPECIFICATIONS—Statements that specify types and quality of materials and installation methods.

STRUCTURAL PLANS—All structural members of the building, including foundation, details and sections, walls, columns and beam sections, or details.

SUCTION HEAD—Total pressure of the liquid entering the pump.

SUPERVISION—To oversee or monitor in order to direct, as in employees.

SURFACE WATER—Water in exposed streams, rivers, lakes, and ponds.

TOTAL DISCHARGE HEAD—The difference between pump suction head and the discharge head.

TURBIDITY—Cloudiness in water caused by suspended solids.

UNLOADERS—System for removing all but friction loads from a compressor.

VALVE—A device for regulating, stopping, or starting flow in a system, and for controlling direction of flow.

VALVE BOX—A pipe over a valve stem or wheel, capped to exclude dirt that might interfere with valve operation but permits access to the valve stem for opening or closing purposes.

VENT—A piping system that prevents siphonage of the trap seal by equalizing the pressure on the outlet side of a trap with the inlet side.

YARNING IRON—A plumbing tool used to peak oakum into a cast-iron hub and spigot lead joint.

CHEMICALS USED IN WATER TREATMENT

ALUMINUM HYDROXIDE—AlOH, reagent, used to decolorize water samples when performing chloride tests on water.

ALUMINUM SULFATE—(Alum), $Al_3(SO_4)_3$, a white salt, a coagulant, used to flocculate dissolved solids in a weak acid water environment.

AMMONIA—NH_3, an alkaline colorless gas, used in solution to detect leaks in chlorine equipment and systems.

BARIUM CHLORIDE—$BaCl_2$, reagent, used to test for sulfates in water.

CALCIUM HYPOCHLORITE—$CaCl_2O_2$, a granular white powder used to disinfect water.

CARBON DIOXIDE—CO_2, a liquid, is used to lower pH of softened and settled potable water.

CHLORINE—Cl_2, a natural chemical element (Cl). A powerful disinfectant, used extensively in water treatment. As a gas, its color is greenish yellow, and it is 2 1/2 times heavier than air. As a liquid, its color is amber, and it is about 1 1/2 times heavier than water. It is an oxidizer and is toxic to all organisms and corrosive (in the presence of water) to most metals.

DIAMINETETRACETATE—(EDTA), reagent, used in solution with Sodium Ethylene to detect minerals which cause hardness in water.

FERRIC CHLORIDE—$FeCl_3$, a dark salt that hydrates to a yellow-orange form. A coagulant, used to flocculate dissolved solids in a strong acid water environment.

FERRIC SULFATE—FeS_3, a coagulant, used to flocculate dissolved solids in a strong acid water environment.

FERROUS SULFATE—$FeSO_4$, a coagulant, used to flocculate dissolved solids in a strong base (alkaline) water environment.

HYDRATED LIME—(Caustic Lime) $CaOH_2$, a dry white powder, a strong base (alkaline), consists of calcium hydroxide made by treating caustic lime with water. Used to balance water pH and absorb chlorine.

METHYL ORANGE—Reagent, used in solution to determine the alkalinity of water.

METHYL PURPLE—Reagent, used in solution to determine the alkalinity of water

PHENOLPHTHALEIN—$C_{20}H_{14}O_4$, reagent, used as an pH indicator for water testing. Red color in bases (alkalines) or decolorized in an acid.

POTASSIUM CHROMATE—KCr, reagent, used in testing for chlorine levels in water.

POTASSIUM HYDROXIDE—(Caustic Potash) K_2CrO_7, a white powder, strongly basic (alkaline), when dissolved in water produces heat. Used to balance water pH and absorb chlorine. Also used as a reagent to test water salinity.

SILVER NITRATE—$AgNO_3$, reagent, used to determine amount of salinity and chloride in water.

SODIUM CARBONATE—(Soda ash), Na_2CO_3, salt of carbonic acid, strongly basic (alkaline). Used in water softening and balancing water pH to aid coagulation.

SODIUM ETHYLENE—(EDTA), $Na_2CH_3CH_2$, reagent, used in solution with Diaminetetracetate to detect minerals which cause hardness in water.

SODIUM HYDROXIDE—(Caustic Soda) NaOH, a strong base (alkaline), white powder used to balance pH in water to aid coagulation, and absorb chlorine.

SODIUM HYPOCHLORITE—NaOCl, a salt usually furnished in solution, used for disinfection of water.

SULFURIC ACID—(Standard), H_2SO_4, strong acid, used to balance water pH and aid in coagulation.

THIOSULFATE—A salt, used to neutralize chlorine water. Used to sterilize water sample containers.

APPENDIX II

ANSWER KEY

CHAPTER 1 - PLANS, SPECIFICATIONS, AND COLOR CODING

PLANS

Q1. Five.

Q2. Architects and engineers.

Q3. Architectural drawings.

Q4. Working drawings.

ISOMETRIC SKETCHING

Q5. Three-dimensional.

Q6. 30° and 60°.

Q7. There is only a single view, which decreases room for dimensions.

SPECIFICATIONS

Q8. No.

Q9. Division 11 - Equipment.

Q10. 15.1a-05.

Q11. When the material is not available and a substitute is needed:

CREW LEADER

Q12. Save time and money.

Q13. Ensure the crew is clear on what is required to construct the project.

COLOR CODING

Q14. Oxidizing materials.

Q15. Written titles.

Q16. White.

Q17. The secondary hazard of the material.

Q18. Indicates direction of flow.

CHAPTER 2 - ADVANCED BASE FUNCTIONAL COMPONENTS

ABFC SYSTEM

Q1. The construction of advanced bases.

Q2. Inventory all parts and check them against the Bill of Material.

Q3. Upstream.

Q4. Wood or coal.

Q5. A burner compartment and a flue compartment.

Q6. Hinged hood that covers the top of the burner.

Q7. In the top position.

Q8. Quantity of sewage and leaching characteristics of the percolating area.

Q9. Two times the width.

Q10. Three feet.

Q11. Sixteen seat.

Q12. Formula chart.

Q13. Purified or distilled water.

Q14. Fifteen feet.

Q15. 600-GPH Reverse Osmosis Water Purification Unit.

CHAPTER 3 - PLUMBING

TOOLS

Q1. Proper tool for the proper job.

Q2. Table of Allowance (TOA).

UNDERGROUND SANITARY PIPING

Q3. To transfer sewage from the source to the plant.

Q4. 1) Trenching & grading; 2) measuring & cutting; 3)laying pipe; 4) joining pipe; 5) testing; and 6) backfilling & tamping.

Q5. The direction of flow.

Q6. Engineering Aids.

Q7. 1) Cast-iron; 2) vitrified clay; 3) concrete; and 4) plastic.

Q8. Five and ten feet.

Q9. Snap off or chain cutter.

Q10. Polyvinylchloride.

Q11. Fillet welding uses a rod to weld the pipe together; whereas, fusion welding uses only the pipes themselves.

SANITARY DRAINAGE INSTALLATION

Q12. Ten feet.

Q13. Fifteen minutes.

Q14. Peppermint oil.

Q15. Four feet.

Q16. Four inch layers.

ABOVEGROUND SANTITARY DRAINAGE

Q17. Cast-iron and silicon.

Q18. Water that is held in the bent portion of the fixture trap. Seals against passage of sewer gases.

Q19. Pipe vents.

WATER SERVICE

Q20. Twenty foot lengths.

Q21. One foot above and ten feet away.

Q22. Type L copper.

Q23. Type M copper.

Q24. Seven.

Q25. Measurement is made from the end of the pipe to the center of the fitting.

Q26. It causes corrosion.

Q27. Heating (Steam & hot-water), and Air compressor systems.

Q28. Eight inches or greater.

Q29. Cement-asbestos.

CHAPTER 4 - PLUMBING VALVES AND ACCESSORIES

VALVES

Q1. The internal structure of the valve.

Q2. An arrow or the word “Inlet”.

Q3. Fire sprinkler systems.

Q4. The inside of the valve bonnet flange is bored true with the valve seat.

VALVE ACCESSORIES

Q5. Non-rising stem gate valves below the ground or floor level.

Q6. Valve Box.

WATER METERS

Q7. To measure the flow of water within a line to a point of distribution.

Q8. If the meter is measuring cubic feet or gallons.

Q9. Clockwise.

FIRE HYDRANTS

Q10. The Fire Department.

Q11. Dry barrel and wet barrel.

DISINFECTION OF WATER SUPPLY SYSTEM COMPONENTS

Q12. 150 ppm.

Q13. 2.61 gallons.

Q14. Three feet per second.

Q15. To prevent separation of the pipe due to water pressure in the pipe.

SHORING AND SCAFFOLDING

Q16. More than 5 feet in height.

WASTEWATER SYSTEMS

Q17. 3.4 inches per foot.

Q18. Changes in the direction of the sewer line.

WATER DISTRIBUTION SYSTEMS

Q19. At least 50 feet.

Q20. Twenty four inches.

CHAPTER 5 - PLUMBING FIXTURES AND PLUMBING REPAIRS

PLUMBING FIXTURES

Q1. Rough-in measurements.

Q2. One cubic foot per minute.

Q3. Twenty five fixture units.

Q4. Less.

Q5. Floor and wall mounted urinals.

Q6. Slop sink.

Q7. Hose bib

Q8. Manufacturer's specifications.

PLUMBING REPAIRS

Q9. Thawing.

Q10. 500 amperes.

PIPE LEAKS

Q11. Fracture or rupture.

Q12. Leaky seams and corroded areas.

WATER CLOSETS

Q13. Failed seal or gasket.

Q14. Inlet valve (ball cock) assembly.

FLUSHOMETERS

Q15. Diaphragm and piston.

Q16. The relief valve does not seat properly.

Q17. Causes swelling of the diaphragm and inproper operation.

FAUCETS

Q18. Faucet seat.

Q19. A flat or beveled washer of the same size and design.

SEWER MAINTENANCE AND REPAIR

Q20. Determine the cause of the problem.

Q21. A 2 ½" diameter.

Q22. At a manhole.

CLEARING STOPPAGES IN FIXTURES

Q23. False.

Q24. True.

SAFETY

Q25. Ensure the manhole has been inspected and cleared for entry by a qualified person in Confined Space Entry.

Q26. Goggles and gloves.

GAUGES

Q27. Weight is applied to a plunger.

Q28. Diaphragm type gauge.

CHAPTER 6 - PRIME MOVERS, PUMPS, AND COMPRESSORS

PRIME MOVERS

Q1. Driving equipment.

Q2. Belt slippage.

Q3. Prestart inspection.

Q4. Method of introduction of the fuel and air into the cylinders.

PUMPS

Q5. Fluid end.

Q6. The net difference between the suction head and the discharge head.

Q7. Leakage, fluid friction, and dissolved gases in the liquid.

Q8. Rotary, reciprocating, centrifugal, air-lift, and jet.

Q9. A positive displacement pump.

Q10. The gear and screw type.

Q11. Direct-acting, simplex, double-acting, and vertical.

Q12. A wheel or impeller.

Q13. It decreases.

Q14. Air-lift.

INSTALLATION OF PUMPS

Q15. More liquid will enter one side of the impeller than the other.

Q16. To avoid air pockets that throttle the system or lead to erratic pumping.

Q17. An unstable operation, such as cavitation.

Q18. Overheating.

Q19. Better sealing qualities and longer serviceability.

Q20. Every 6 months.

Q21. Every year.

AIR COMPRESSORS

Q22. Reciprocating, centrifugal, and rotary.

Q23. Electric motors.

Q24. Friction loads.

Q25. To cool the final discharge air from the compressor.

Q26. Traps.

CHAPTER 7 - WATER TREATMENT

THE WATER CYCLE

Q1. Surface and groundwater.

Q2. Zones of soil moisture, aeration (precolation), and saturation.

QUALITY OF WATER

Q3. Time between contact with water and appearance of the disease.

Q4. Dissolved and suspended.

Q5. Amoebic dysentary.

Q6. Sedimentation.

Q7. Chlorine.

SANITARY DRAINAGE PIPING

Q8. Method of control.

Q9. Direct-feed.

Q10. Proper ventilation.

Q11. Ammonia.

Q12. Waste gas into a caustic soda solution.

WATER TREATMENT QUALITY CONTROL

Q13. Uncontaminated.

Q14. Pump the well until normal draw-down is reached.

Q15. Three inches below the surface at a 45° angle.

TREATMENT CONTROL TEST PROCEDURES

Q16. Proper operation and acceptable water quality.

Q17. Orthotolidine and Orthotoline-arsenite tests.

Q18. Neutral pH.

Q19. 3.9 ppm of chloride.

Q20. Determine proper chemical dosage and conditions for coagulation.

CHAPTER 8 - EQUIPMENT MAINTENANCE

CHLORINATORS

Q1. By method of feed and type of diaphragm controlling chlorine feed.

Q2. Manually.

Q3. Gas chlorinators.

Q4. Daily.

MAINTENANCE OF CHEMICAL FEEDERS

Q5. Chemical goggles or a mask.

Q6. Quarterly.

Q7. Cleaning, repairing, and painting.

MAINTENANCE OF ION-EXCHANGE UNITS

Q8. Annually.

Q9. No, but grease will get into the water if left in service during lubrication.

Q10. 7.0 or neutral.

Q11. Evaporated salt.

MAINTENANCE OF CLARIFICATION EQUIPMENT

Q12. Drinking water supply.

Q13. .Impressed current and galvanic anode systems.

Q14. Galvanic anode.

MAINTENANCE OF FILTRATION EQUIPMENT

Q15. Daily.

Q16. Remove filter from service and treat with a strong hypochlorite solution.

Q17. Alum floc penetration.

Q18. Direct or indirect acting.

Q19. Filter medium is housed in a enclosed pressure shell.

Q20. Oxalic acid at 5%.

MAINTENANCE OF AREATION EQUIPMENT

Q21. Cascade or step action.

Q22. An explosion and acid splatter.

Q23. Organic growths, such as algae.

SAFETY AND EMERGENCIES

Q24. Only what is required for daily use.

Q25. Ammonia solution.

Q26. Remove them to open air away from gas fumes.

RESPIRATORY BREATHING APPARATUS

Q27. Toxic gases or vapors and oxygen deficient.

Q28. Test for leakage.

Q29. Every 5 years.

WATER STORAGE FACILITIES

Q30. Ground level, underground, and elevated.

Q31. Steel and concrete.

Q32. Portland cement slurry.

Q33. Impressed current.

APPENDIX III

TABLES FOR MAINTENANCE PROCEDURES

Maintenance Procedures for Chlorination Equipment
Table A

Inspection	Action	Frequency
Operator maintenance	Insert new lead gasket in chlorine valves or tubes to cylinders or equipment	V
Condensation on chlorine cylinders	Ventilate	V
Chlorine leak detection	Use unstoppered bottle of aqua-ammonia to detect leaks; repair immediately	D
Gas system	Inspect, clean, and replace faulty parts in piping, meters, valves and tubing	D
Chlorine valves	Open and close valves to ensure that none are frozen in a set position; check stuffing boxes, and repair or replace faulty valves or packing	D
Chlorine feeder water supply	Clean water strainers and pressure reducing valves; adjust float valves and ejector capacity	M
Hard-rubber threads, valves and parts	Disassemble or operate; use graphic grease to prevent freezing; hand tighten only, do not use tools	Q
Vacuum relief	Clean out any obstructions	D
Cabinet and working parts	Clean all parts where accumulation may interfere with proper operation	W
Direct feed chlorinators	Use same procedures as for solution feed machines where they apply	
Hypochlorinators	See table C	

Symbols used for frequency are a follows:
D = DAILY W = WEEKLY M = MONTHLY Q = QUARTERLY
SA = SEMIANNUALLY A = ANNUALLY V = VARIABLE, AS CONDITIONS MAY INDICATE

Maintenance Procedures for Dry Chemical Feeders
Table B

Inspection	Action	Frequency
Dry feeders	Remove chemical dust accumulations; check feeder performance; check for loose bolts; clean solution tank of accumulated sediment; lubricate moving parts	D
Drive mechanisms and moving parts	Service and lubricate	Q
Calibration	Check feed-rate accuracy and adjust as necessary	M
Feeders out-of-service	Clean, remove all chemicals from hopper and feeder mechanism	V
Disk feeders	Clean rotating disk and plow	M
Oscillating feeders	Check and adjust mechanism and adjustable stroke rod	M
Rotary gate feeders	Clean pockets of star feeder and scraper	M
Belt-type feeders	Check vibratory mechanism, tare-balance, feeding gate, belt drive and belt; calibrate delivery	M
Loss-in-weight feeders	Check feeder scale sensitivity, tare-weight, and null balance	M
Screw feeders	Clean screw, check ratchet drive, or variable speed drive	M
Lime slakers	Clean dust-removal and vapor-removal equipment; remove clinker	D
	Clean equipment; wipe off feeder; check operation of vapor-removal equipment; clean compartments	W
Dust collectors	Repair agitators, stirrers, and heat exchanger baffles	M
Motors	Lubricate motors	V
Dust collector filter bags	Check conditions and attachment; securely attach sound bags; replace damaged or tom bags	V

Symbols used for frequency are as follows:
D = DAILY W = WEEKLY M = MONTHLY Q = QUARTERLY
SA = SEMIANNUALLY A = ANNUALLY V = VARIABLE, AS CONDITIONS MAY INDICATE

Maintenance Procedures for Liquid and Solution Chemical Feeders
Table C

Inspection	Action	Frequency
Pot feeders		
Flow through pot	Determine amount of chemical fed to ascertain if flow through pot is effective	D
Sediment trap	Clean trap and check needle valve	M
Chemical pot	Clean pot and orifice	SA
Differential solution feeders		
Chemical storage tank	Inspect and clean	SA
Oil volume	Check and replenish	SA
Pilot tubes and needle valve	Check and replace as necessary	A
All equipment	Paint as necessary	V
Decanter or swing-pipe feeder		
Swing-pipe	Check to make certain it does not bind	M
Motor ratchet, pawl, reducing gears	Check and lubricate	SA
Rotating dipper feeder		
Motor	Follow manufacturer's instructions	V
Transmission	Change oil after 100 hours operation Drain and flush, clean interior, and refill	100 hrs SA
Shaft bearings	Lubricate	W
Drive chain	Clean, check alignment; check sprocket teeth; lubricate chain and sprockets	M
Agitator	If used, clean and lubricate according to manufacture's instructions	V
Belt drives	Check alignment, tension, and inner cords of belt drives	M
Dipper and float valve	Check dipper clearance and adjust float valve setting	SA
Portioning pumps (Hypochlorinators)		
Operator inspection	Inspect sight feeders, rate of flow, piping, joints	D
Feeder	Clean feeder	W
Solution tank	Clean tank	M
Linings	If cracks occur, special linings should be repaired	A

Symbols used for frequency are as follows:
D = DAILY W = WEEKLY M = MONTHLY Q = QUARTERLY
SA = SEMIANNUALLY A = ANNUALLY V = VARIABLE, AS CONDITIONS MAY INDICATE

Maintenance Procedures for Ion-Exchange Softening Units
Table D

Inspection	Action	Frequency
Softener unit		
Shell	Clean and wire brush; paint	A
Valves and fittings	Check for obstructions, corrosion, and fastness	Q
Multi-port valves	Check for leaks; repack if necessary	SA
	Lubricate with grease; follow directions for lubrication procedures	SA
Ion-exchangemedium	Check bed surface for dirt, fines and organic growths; remove foreign matter and resin to desired to desired level	Q
Gravel	Probe through resin to determine gravel surface; level gravel surface with rake during backwash flow; replace gravel when caked, or if resin is being lost to effluent; wash and grade gravel and place in four separate layers; use new lime-free gravel at discretion of inspector	Q
Underdrains	Check pressure drop through underdrains; if necessary, remove manifold or plate underdrains; clean and replace	A or V
Regeneration equipment		
Salt storage unit	Clean tank as necessary to remove dirt	V
Brine tank	Clean out dirt and insolubles; allow to dry; paint both exterior and interior surface	SA
Ejector	Clean, disassemble, check erosion, and corrosion; clear clogged piping; assemble and replace	A
Operating conditions		
Flow rates	Check rate of flow through bed; adjust controls to optimum rate, depending on type of resin	Q
Backwash rates	Check rate and adjust controls to optimum rate	Q
Pressure	Check difference between inlet and outlet pressures; if undersirable changes in pressure drop have occurred, seek cause and remedy	Q
Efficiency	Compare total softening capacity with previous inspection; determine cause of decrease, if any, and remedy the situation	Q
Out-of-service softeners	Drain; keep synthetic resins damp; do not regenerate before draining	V

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Maintenance Procedures for Clarification Equipment
Table E

Inspection	Action	Frequency
Mixing basins	Drain, wash down walls, flush sediment to waste line; repair spalled spots on walls and bottom; check valves on sluice gates; lubricate and paint valves as necessary	SA
Baffled mixing chambers	Clean baffles and clean as necessary	SA
Flocculator basins	Check paddle rotation to ascertain if any flocculators are inoperative	M
	Clean and lubricate drive, bearings, gears, and other mechanical parts; check underwater bearings for silt penetration; replace scored bearings	SA
Rapid (flash) mixers	Check paddles; clean bearings and drive shaft; lubricate and paint as necessary	SA
Revolving-sludge-collector basins	Drain tank, check submerged parts	SA
Operating parts	Lubricate	D or W
Speed reducers and oil baths	Remove water and grit, replace oil as necessary	W
Drive head	Lubricate	D
Worm gear	Check oil level	W
	Drain water from housing	M
Turntable bearings	Lubricate	M
	Change oil	SA
Chains	Drain off water, add oil as necessary	M
	Change oil	SA
Annular ball bearings	Lubricate	D
Center bearings, shaft bearings, bushings, etc.	See manufacturer's instructions	V
Tank equipment	Tighten bolts and nuts; check for excessive wear; flush and back blow sludge line; check motors, couplings and shear pins; check rakes, clean and paint equipment	A
Conveyor-type-collector basins	Consult manufacturer's instructions	V
Upflow clarifier	See manufacturer's instructions	V
Cathodic protection rectifier-type	Check exterior and interior for condition; see manufacturer's instruction; repair, replace, or paint	M
Sacrificial anode	Check anode condition and all connections, and replace as necessary	M

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Maintenance Procedures for Filtration Equipment
Table F

Inspection	Action	Frequency
Gravity filters		
Filter media	Inspect surface for unevenness sinkholes, cracks, algae, mud balls, or slime	M
	Dig out sand and gravel at craters of appreciable size; locate and repair underdrain system breaks	V
	Chlorinate to kill algae growths	V
	Probe for hard spots and uneven gravel layers; if present, treat filter with acid	Q
	Check wash water rise rate and sand expansion during back-washing	SA
	Check sand condition for grain size growth; sample sand, determine weight loss on acid digestion, and run sieve test; acid-treat if necessary, or replace sand if necessary	SA
Gravel	Check elevation of gravel surface	M
	Examine gravel for incrustation, cementation, alum penetration, mud balls; if necessary, remove, clean, and relay gravel	SA
Underdrain system	Remove sand from area of 10 sq. ft., and inspect 2 sq. ft. area of gravel (or more); if underdrains are deteriorated, remove all sand and gravel, repair underdrains, replace gravel and sand	A
	If porous underdrain, clogged by alum floc, treat with 2% sodium hydroxide solution for 12 to 16 hours	V
Wash water troughs	Check level and elevation, adjust	Q
	Check for corrosion; if present, dry troughs, wire brush, and paint	SA
Operating tables	Clean table (console or panel) inside and out	W
Cables	Adjust tension	V

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Inspection	Action	Frequency
Hydraulic lines (or pneumatic)	Check for leakage	V
Four-way valves	Adjust, tighten packing glands or add new packing	M
Transfer valves	Lubricate with grease	M
Valve-position indicator	Adjust if necessary	M
Four-way transfer valves	Disassemble, clean, lubricate, and replace worn parts	A
Table	Paint inside	A
Rate controllers Direct-acting	Clean exterior, check diaphragm leakage, tighten packing, check freedom of movement and zero differential	W
Diaphragm pot	Disassemble, clean and replace	V
Controller mechanism	Disassemble, service; clean venturi; paint surfaces needing protection	Every 3 Yrs.
Indirect-acting	Clean outside, adjust packing, lubricate and tighten fittings; check knife edges, check piston travel; repack as necessary	W
Pilot valves	Disassemble, clean and lubricate; check piston travel; clean piping and strainers; check for leaks in diaphragm	A
Controller mechanism	Disassemble, service; clean venturi; clean hydraulic cylinders; paint as necessary	Every 3 Yrs.
Mechanically-operated loss-of head gauges	Check zero setting; adjust stop collars or cable; release air from float chamber	M
Mud leg	Flush out sediment	M
Float chamber	Remove float, clean; remove mercury, clean and replace; check pressure pipelines; paint interior and exterior	A
Diaphragm-pendulum loss-of-head unit	Check zero setting; purge diaphragm cases of air; check cable at segment; remove dirt form knife edges; tighten can hubs on shafts; drain mud from mud leg	M
Pipelines to diaphragm	Check for free flow and absence of incrustation	SA
Diaphragm-pendulum unit	Check for leakage; disassemble unit; clean and lubricate; check working parts, cables; repack stuffing box	A

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Inspection	Action	Frequency
Mercury-float-type rate-of-flow gauges	Check at zero differential, adjust indicator arm and recording pens; check stop collars on cables	-
	Check accuracy and percent error; if greater than ± 3%, adjust	SA
Pressure lines		SA
Float chamber	Check and clean as necessary	A
	Clean float and mercury; paint all parts requiring protection	
Piping and valves	Check for joint leaks; check pipe hangers, replace if necessary; paint as necessary	M
Pressure filters		
Piping and valves	Check for leaks; lubricate and repack valves as necessary	W
Filter bed	Open pressure shell, check sand surface for mud balls, unevenness; check sand surface elevation; remove mud balls	Q
	Remove sand in sizable area and check gravel	A
Pressure she	Clean and paint exterior	A
Underdrains	Remove sand, check gravel; remove gravel, check underdrains; clean, paint, and repair; replace gravel and sand	Every 3 Yrs.
Diatomite filters		
Filter elements	Check for clogging; clean as necessary (e.g., treat to remove iron oxide, manganese dioxide, and algae)	M
Piping and appurtenant equipment	Check for leaks; clean and repair auxiliaries	SA
Exterior surfaces	Clean and paint	A

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Maintenance Procedures for Aeration Equipment
Table G

Inspection	Action	Frequency
Waterfall-type aerators (cascade)	Inspect aerator surfaces; remove algae;	D
	Repair or replace surfaces as necessary	A
Waterfall-type aerators (tray)	Clean and repair trays; clean coke or replace	SA
Injection aerators porous ceramic plate or tube	Check discharge pressure; if clogging is evident, dewater tank; clean diffusers	V
	Drain aeration tank, check for joint leaks, broken diffusers, clogging	SA
Waterside of ceramic diffusers	Clean with acid, in place, or remove and soak in acid	SA
Air side of ceramic diffusers	If plates are clogged by iron oxide, treat with HCl; if clogged by soot, oil, etc., remove diffusers and burn	SA
Saran-wound diffusers	Clean by scrubbing with soap or detergent	SA
Nozzles	Clean nozzles inside and out	SA
Spray nozzle aerators		
Nozzles	Check for clogging; clean, remove if necessary to clean	W
Manifolds	Remove caps and clean out sediment; check pipe supports, repair as necessary; paint as necessary	Q
Spray fence	Paint	A
Blowers and accessory equiment		
Compressor or blower	Lubricate, check output pressure for indications of clogging	D
Air filters		
Compressors or blower	Clean, repair, or replace	W
	Open, inspect, clean, repair, and paint exterior surfaces	A

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Maintenance Procedures for Storage Facilities
Table H

Inspection	Action	Frequency
Foundations, concrete	Check for settlement, cracks, spalling and exposed reinforcing; repair as necessary with 1 part cement to 1 part sand	SA
Foundations, wood	Check wood foundations and pads for cracked, split, rotted or termite infected members; also check for direct contact of untreated wood with soil; repair or eliminate undesirable conditions as necessary	SA
Concrete tanks (ground level storage)		
Walls	Check exterior for seepage and mark spots	SA
	Check exterior and interior for cracks, leaks, spalling, etc.	A (Spring)
	Remove loose, scaly, or crumbly concrete; patch with rich cement grout; paint grout with iron waterproofing compound	A
	Chip out cracks, repair with cement slurry	A
	For cracks in prestressed tanks, consult designing and/or erecting company	A
Expansion joints	Check for leakage; check for missing filler; clean and repair as necessary	SA
Roofs	Check condition; check hatches; check screens or openings	SA
Earth embankments	Check for erosion, burrowing animals, improper drainage and leakage through embankment; repair as necessary; if leakage through embankment exists, drain tank and look for cracks in tank walls or bottom	SA
Concrete tanks (underground storage)	Check interior walls, roof, appurtenances and embankment; if leakage is evident, excavate and repair walls	SA

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Inspection	Action	Frequency
Concrete tanks (elevated storage)	Check and repair	SA
Steel tanks (ground level storage)	Check for ice damage in Spring; repair as necessary	A
Walls and bottom	Examine exterior and interior for rust, corrosion products, loose scale, leaky seams, and rivets and for condition of paint	SA
	Replace rivets or patch leaking areas as necessary	V
	Check painted surfaces for deterioration; paint as necessary	
Roofs	Check conditions, hatches, screens, manholes and paint; lock hatches; remove spider rods if corroded; repair, replace, as necessary	SA
Steel tanks (standpipes)	Follow instructions for ground level storage given earlier in this chapter	SA
Steel tanks (underground storage)	Check tank interior, roof, and appurtenances; follow instructions given earlier in this chapter	SA
Steel tanks (elevated storage)	For general procedures follow instructions given earlier in this chapter; for specific procedures see following paragraphs	SA
Tanks	Follow instructions given earlier	SA

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Inspection	Action	Frequency
Tower structures	Check for corrosion; loose, missing, bowed, bent or broken members; loose sway bracing; mis-alignment of tower legs; evidence of instability; repair as necessary	SA
	Check surface of lattice bars, anchor bolts, boxed channel columns and pockets where water or trash collects; clean, repair, provide drainage or fill pockets; paint as necessary	SA
Roofs	Follow the general instructions given earlier in this chapter	SA
	Check obstruction and navigation lights, hoods, shields, receptacle and fittings for missing or damaged parts, or inoperation; also check lighting rods, terminals, cables, and ground connections; repair, replace, or renew; paint as necessary	SA
Risers and heating systems	Two months before freezing weather, check riser pipe insulation and repair as necessary; also check heating system operation	A
	One month before freezing weather, operate heating system for eight hours; repair or adjust defective parts	A
Cathodic protection	In addition to the following instructions, observe those given earlier in this discussion regarding cathodic protection of sedimentation tank equipment	V (at least A)
	Check flow of current; if absent, check fuses, electrodes, ground wire connections and immersion of electrodes; adjust or repair as necessary; if current flow or amperage is above desired level, adjust as necessary; make certain that connections to rectifier are not reversed	V
	Check operating records to make sure that electrodes are immersed at all times	V
	Check anode condition; replace as necessary	V
	In freezing climates, protect electrodes against ice damage, or remove and store for winter season	V

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Inspection	Action	Frequency
Pneumatic tanks	Inspect air pump and motor; check operating record of time cycle; check for air leaks, if time cycle is too short; check valve operations, particularly pressure relief valves Check tank for signs of corrosion; take steps necessary to eliminate corrosion or protect against it	Q
Appurtenances	Check ladders, walkways, guardrails, hand-rails, stairways, and risers for rust, corrosion, poor anchorage, missing pieces, general deterioration or damage; replace or repair parts as necessary	A
Miscellaneous appurtenance	Check all electrical connections and conduits leading to tanks; make any repairs or adjustments necessary	SA
Grounds	Check for accumulations of debris, trash and foliage; clean the area	SA

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APPENDIX IV

MATH TABLES, EQUIVALENTS, AND USEFUL FORMULAS

TABLE FOR CONVERSION OF
ENGLISH AND METRICMEASUREMENTS

MULTIPLY	BY	TO OBTAIN
Cubic feet	2.832×10^{6}	Cubic cms
Cubic feet	1728	cubic inches
Cubic feet	0.02832	cubic meters
Cubic feet	0.03704	cubic yards
Cubic feet	7.481	gallons
Cubic feet	28.32	liters
Cubic feet	59.84	pints (liq)
Cubic feet	29.92	quarts (liq)
Cubic inches	16.39	cubic centimeters
Cubic inches	5.787×10^{-4}	cubic feet
Cubic inches	1.639×10^{-5}	cubic meters
Cubic inches	2.143×10^{-5}	cubic yards
Cubic inches	4.329×10^{-2}	gallons
Cubic inches	1.639×10^{-2}	liters
Cubic inches	0.03463	pints (liq)
Cubic inches	0.01732	quarts (liq)
Cubic yards	7.636×10^{5}	cubic centimeters
Cubic yards	27	cubic feet
Cubic yards	46.656	cubic inches
Cubic yards	0.7646	cubic meters
Cubic yards	202.0	gallons
Cubic yards	764.6	liters
Cubic yards	1616	pints (liq)
Cubic yards	807.9	quarts (liq)
Feet	30.48	centimeters
Feet	0.3048	meters
Feet	.36	yards
Feet	1/3	yards
Feet of water	0.02950	atmosphere
Feet of water	0.8826	inches of mercury
Feet of water	304.8	kgs per sq meter
Feet of water	62.43	pounds per sq ft
Feet of water	0.4335	pounds per sq inch
Gallons	3785	cubic centimeters
Gallons	0.1337	cubic feet
Gallons	231	cubic inches
Gallons	3.785×10^{-3}	cubic meters
Gallons	4.951×10^{-3}	cubic yards
Gallons	3.785	liters

TABLE FOR CONVERSION OF
ENGLISH AND METRICMEASUREMENTS (CONTINUED)

MULTIPLY	BY	TO OBTAIN
Inches	2.540	centimeters
Inches	10^4	mils
Inches	.03	yards
Inches of mercury	0.63342	atmosphere
Inches of mercury	1.133	feet of water
Inches of mercury	345.3	kgs per sq meter
Inches of mercury	70.73	pounds per sq ft
Inches of mercury	0.4912	pounds per sq inch
Inches of water	0.002458	atmospheres
Inches of water	0.07355	inches of mercury
Inches of water	25.40	kgs per sq meter
Inches of water	0.5781	ounces per sq in
Inches of water	5.204	pounds per sq ft
Inches of water	0.03613	pounds per sq inch
Ounces	8	drams
Ounces	437.5	grains
Ounces	28.35	grams
Ounces	0.0625	pounds
Ounces (fluid)	1.805	cubic inches
Ounces (fluid)	0.02957	liters
Pounds	7000	grains
Pounds	453.6	grams
Pounds	16	ounces
Pounds	32.17	poundals
Pounds	0.8229	pounds (av)
Pounds of water	0.01602	cubic feet
Pounds of water	27.68	cubic inches
Pounds of water	0.1198	gallons

MULTIPLY	BY	TO OBTAIN
Centiliters	0.01	Liters
Centimeters	0.3937	inches
Centimeters	0.01	meters
Centimeters	393.7	mils
Centimeters	10	millimeters
Cubic centimeters	3.531×10^{-3}	cubic feet
Cubic centimeters	6.102×10^{-2}	cubic inches
Cubic centimeters	10-6	cubic meters
Cubic centimeters	1.306×10^{-6}	cubic yards
Cubic centimeters	2.642×10^{-4}	gallons
Cubic centimetersCubic centimeters	10-2	liters
	2.113×10^{-3}	pints (liq)
Cubic centimeters	1.057×10^{-3}	quarts (liq)
Cubic meters	10^{4}	cubic centimeters
Cubic meters	35.31	cubic feet
Cubic meters	81.023	cubic inches
Cubic meters	1.303	cubic yards
Cubic meters	264.2	gallons
Cubic meters	10^{2}	liters
Cubic meters	2113	pints (liq)
Cubic meters	1057	quarts (liq)
Kilograms	10^{2}	grams
Kilograms	70.93	poundals
Kilograms	2.2046	pounds
Kilograms	1.102×10^{-2}	tons (short)
Kilometers	3281	feet
Kilometers	10^{7}	meters
Kilometers	1093.6	yards
Liters	10^{2}	cubic centimeters
Liters	0.03531	cubic feet
Liters	61.02	cubic inches
Liters	10^{3}	cubic meters
Liters	1.308×10^{-2}	cubic yards
Liters	0.2642	gallons
Liters	2.113	pints (liq)
Liters	1.057	quarts (liq)
Meters	100	centimeters
Meters	3.2808	feet
Meters	39.37	inches
Meters	10^{-3}	kilometers
Meters	10^{3}	millimeters
Meters	1.0936	yards
Millimeters	25	inches

EQUIVALENTS

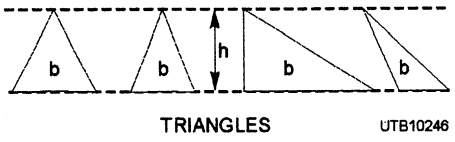
1 inch	=	25 millimeters
1 foot	=	0.3 meter
1 yard	=	0.9 meter
1 mile	=	1.6 kilometers
1 square inch	=	6.5 square centimeters
1 square foot	=	0.09 square meter
1 square yard	=	0.8 square meter
1 cubic inch	=	16 cubic centimeters
1 cubic foot	=	0.03 cubic meter
1 cubic yard	=	0.8 cubic meter
1 quart (lq.)	=	1 liter
1 gallon	=	0.004 cubic meter
1 ounce (avdp)	=	28 grams
1 pound (avdp)	=	0.45 kilogram
1 horsepower	=	0.75 kilowatt
1 pound per square inch	=	0.07 kilograms per square centimeter
1 millimeter	=	0.04 inch
1 meter	=	3.3 feet
1 meter	=	1.1 yards
1 kilometer	=	0.6 mile
1 square centimeter	=	0.16 square inch
1 square meter	=	11 square feet
1 square meter	=	1.2 square yards
1 cubic centimeter	=	0.06 cubic inch
1 cubic meter	=	35 cubic feet
1 cubic meter	-	1.3 cubic yards
1 liter	=	1 quart (lq)
1 gram	=	250 gallons
1 kilogram	=	0.035 ounces (avdp)
1 Kilowatt	=	2.2 pounds (avdp)
1 kilogram per square centimeter	=	1.3 horsepower
	=	14.2 pounds per square inch

USEFUL FORMULAS

Triangle:

$$\text{Area} = \frac{b \times h}{2}$$

$$\text{Volume} = \frac{b \times h}{2} \times \text{length}$$

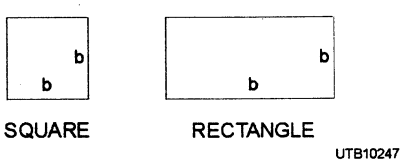


Square/Rectangle:

Area = $b \times b$

Volume = $b \times b \times b$

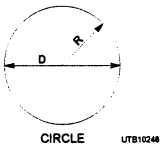
Perimeter = $2b + 2b$



Circle:

Area= $\pi \times R^2$

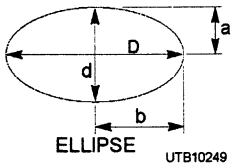
Volume= $\pi \times R^2 \times \text{length}$



Ellipse:

$$\text{Area} = \frac{\pi \times D \times d}{4}$$

$$\text{Volume} = \frac{\pi \times D \times d}{4} \times \text{length}$$



Circular cone:

Lateral area = $s \times \pi \times R$

$$\text{Volume} = \frac{\pi \times R^2 \times h}{3}$$

APPENDIX V

REFERENCES USED TO DEVELOP THE TRAMAN

NOTE: "Although the following references were current when this TRAMAN was published, their continued currency cannot be assured. When consulting these references, keep in mind that they may have been revised to reflect new technology or revised methods, practices, or procedures. You therefore need to ensure that you are studying the latest references."

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